The documentation and process conversion measures necessary to comply with this revision shall be completed by 1 May 1993

INCH-POUND

MIL-S-19500/312C
1 August 1992
SUPERSEDING
MIL-S-19500/312B
23 February 1967

MILITARY SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, SWITCHING
TYPE 2N708, JANTX

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the detail requirements for NPN silicon switching transistors. One level of product assurance is provided for the device type as specified in MIL-S-19500.

1.2 Physical dimensions. See figure 1.

1.3 Maximum ratings.

P_T 1/ T_C = +25°C	P_T 2/ T_A = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	V_{CER} $R_{BE} \leq 10$ ohms	T_{op} and T_{STG}
W	W	V dc	V dc	V dc	V dc	°C
1.2	0.36	40	15	5.0	20	-65 to +200

1/ Derate linearly 6.90 mW/°C above T_C = +25°C.
2/ Derate linearly 2.06 mW/°C above T_A = +25°C.

1.4 Primary electrical characteristics.

	h_{FE2} 1/	$V_{CE(SAT)1}$	$V_{BE(SAT)1}$	t_{on}	t_{off}	$\lvert h_{fe} \rvert$
Limits	V_{CE} = 1.0 V dc I_C = 10 mA dc	I_C = 10 mA dc I_B = 1.0 mA dc	I_C = 10 mA dc I_B = 1.0 mA dc	I_C = 10 mA dc I_{B1} = 3 mA dc V_{BE} = 2 V dc	I_C = 10 mA dc I_{B1} = 3 mA dc I_{B2} = 1 mA dc	V_{CE} = 10 V dc I_C = 10 mA dc f = 100 MHz
		V dc	V dc	ns	ns	
Min	40	---	0.72	---	---	3.0
Max	120	0.4	0.80	40	75	9.0

1/ Pulsed (see 4.5.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Electronics Supply Center, ATTN: DESC-ES, 1507 Wilmington Pike, Dayton, OH 45444-5276 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

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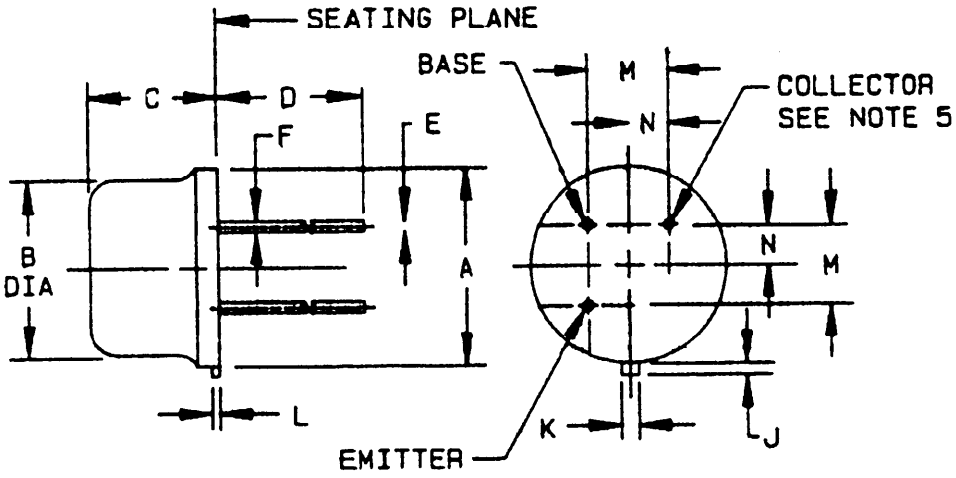

Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
A	.209	.230	5.31	5.84	
B	.178	.195	4.52	4.95	
C	.170	.210	4.32	5.33	
D	.500	---	12.70	---	8
E	---	.021	---	.53	3, 8
F	.016	.019	.41	.48	3, 8
J	.028	.048	.71	1.22	7
K	.036	.046	.91	1.17	
L	---	.020	---	.51	
M	.0707 Nom		1.80 Nom		5
N	.0354 Nom		0.90 Nom		5

NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Measured in the zone beyond .250 inch (6.35 mm) from the seating plane.
4. Measured in the zone .050 inch (1.27 mm) and .250 inch (6.35 mm) from the seating plane.
5. When measured in a gauging plane .054 +.001 -.000 inch (1.37 +.03 -.00 mm) below the seating plane of the transistor, maximum diameter leads shall be within .007 inch (0.18 mm) of their true location relative to a maximum width tab. Smaller diameter leads shall fall within the outline of the maximum diameter lead tolerance. Figure 2 is the preferred measurement method.
6. The collector shall be internally connected to the case.
7. Measured from the maximum diameter of the actual device.
8. All 3 leads.

FIGURE 1. Physical dimensions.

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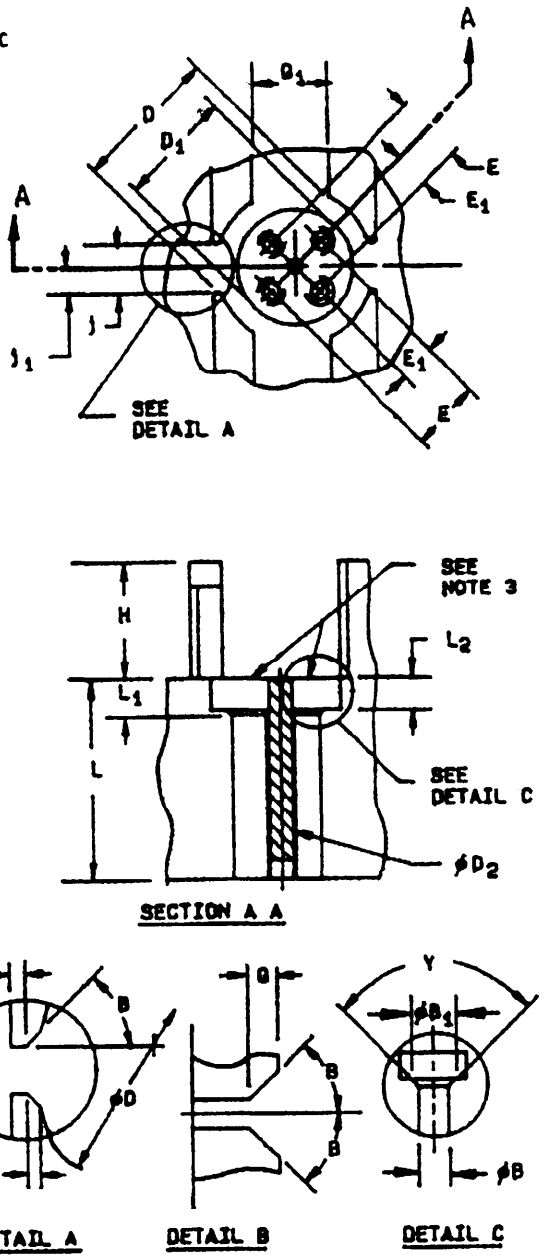
Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
ϕB	.0325	.0335	.8255	.8509	5
ϕB_1	.043 Nom		1.09 Nom		5
ϕD	.2310	.2315	5.867	5.880	
ϕD_1	.159	.161	4.04	4.09	
ϕD_2	.040 Nom		1.02 Nom		6
E	.0995	.1005	2.527	2.553	
E_1	.0495	.0505	1.257	1.283	
H	.145	.155	3.68	3.94	
J	.0470	.0475	1.194	1.207	
J_1	.0235	.0245	.597	.622	
K	.009	.011	.229	.279	
K_1	.005 Nom		.127 Nom		
L	.372	.378	9.45	9.60	
L_1	.054	.055	1.37	1.40	
L_2	.043 Nom		1.09 Nom		
Q	.040 Nom		1.02 Nom		
Q_1	.123	.127	3.12	3.23	
A	44.90°	45.10°	---	---	
B	45° Nom		---		
Y	90° Nom		---		



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. The following gauging procedures shall be used: The device being measured shall be inserted until its seating plane is .125 inch (3.18 mm) +.010 inch (0.254 mm) from the seating surface of the gauge. A force of 8 ±.5 oz. shall then be applied parallel and symmetrical to the device's cylindrical axis. When examined visually after the force application (the force need not be removed) the seating plane of the device shall be seated against the gauge. The use of a pin straightener prior to insertion in the gauge is permissible. A spacer may be used to obtain the .125 inch (3.18 mm) distance from the gauge seat prior to force application.
4. These surfaces to be parallel and in same plane within ±.001 inch (0.025 mm).
5. Four holes.
6. Pressed in.

FIGURE 2. Gauge for lead and tab location.

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated detail specification. The individual item requirements shall be in accordance with MIL-S-19500 and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-S-19500.

3.3 Design, construction, and physical dimensions. The design, construction, and physical dimensions shall be as specified in MIL-S-19500 and figure 1 herein.

3.3.1 Lead material and finish. Lead material shall be Kovar or Alloy 52. Lead finish shall be gold or tin plated. Lead finish shall be solderable as defined in MIL-S-19500 and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition requirements (see 6.2b).

3.4 Marking. Marking shall be in accordance with MIL-S-19500. At the option of the manufacturer, marking of the country of origin may be omitted from the body of the transistor, but shall be retained on the initial container.

4. QUALITY ASSURANCE PROVISIONS

4.1 Sampling and inspection. Sampling and inspection shall be in accordance with MIL-S-19500 and as specified herein.

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-S-19500.

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4.3 Screening (JANTX level only). Screening shall be in accordance with table II of MIL-S-19500 and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table II of MIL-S-19500)	Measurement JANTX level
11	I_{CBO1} and h_{FE2}
12	See 4.3.1
13	Subgroup 2 of table I herein; I_{CBO1} = 100 percent of initial value or 10 nA dc, whichever is greater; h_{FE1} = ±15 percent of initial value.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows:

T_A = +25°C ±3°C; V_{CB} = 12 V dc; P_T = 360 mW.

4.4 Quality conformance inspection. Quality conformance inspection shall be in accordance with MIL-S-19500.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-S-19500 and table I herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table IVb (JANTX) of MIL-S-19500, and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2.1 Group B inspection (table IVb of MIL-S-19500). Subgroup 3: Steady-state operation life (LTPD); method 1027; conditions T_A = +25°C ±3°C; V_{CB} = 12 V dc; P_T = 360 mW.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table V of MIL-S-19500, and as follows. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.3.1 Group C inspection (table V of MIL-S-19500).

a. Subgroup 2: Terminal strength; method 2036; test condition E.

b. Subgroup 6: Steady-state operation life; method 1026; conditions T_A = +25°C ±3°C; V_{CB} = 12 V dc; P_T = 360 mW.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

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TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Breakdown voltage collector to base	3001	Bias condition D; I_C = 1.0 µA dc	$V_{(BR)CEO}$	40		V dc
Breakdown voltage emitter to base	3026	Bias condition D; I_E = 10 µA dc	$V_{(BR)EBO}$	5.0		V dc
Breakdown voltage, collector to emitter	3011	Bias condition D; I_C = 10 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$	15		V dc
Breakdown voltage, collector to emitter	3011	Bias condition B; I_C = 10 mA dc; R_{BE} ≤ 10 ohms; pulsed (see 4.5.1)	$V_{(BR)CER}$	20		V dc
Collector to base cutoff current	3036	Bias condition D; V_{CB} = 20 V dc	I_{CBO1}		25	nA dc
Emitter to base cutoff current	3061	Bias condition D; V_{EB} = 4 V dc	I_{EBO}		80	nA dc
Forward-current transfer ratio	3076	V_{CE} = 1 V dc; I_C = 0.5 mA dc	h_{FE1}	15		
Forward-current transfer ratio	3076	V_{CE} = 1 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE2}	40	120	
Saturation voltage (collector to emitter)	3071	I_C = 10 mA dc; I_B = 1 mA dc	$V_{CE(SAT)1}$		.40	V dc
Base emitter voltage (saturated)	3066	Test condition A; I_C = 10 mA dc; I_B = 1 mA dc	$V_{BE(SAT)1}$	.72	.80	V dc
Base emitter voltage (saturated)	3066	Test condition A; I_C = 1 mA dc; I_B = 0.1 mA dc	$V_{BE(SAT)2}$		.72	V dc

See footnote at end of table.

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TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High-temperature operation:		T_A = +150°C				
Collector to base cutoff current	3036	Bias condition D; V_{CB} = 20 V dc; T_A = +125°C	I_{CBO2}		15	µA dc
Collector to emitter cutoff current	3041	Bias condition A; V_{CE} = 20 V dc; V_{BE} = 0.25 V dc	I_{CEX}		10	µA dc
Saturation voltage (collector to emitter)	3071	I_C = 7 mA dc; I_B = 0.7 mA dc	$V_{CE(SAT)2}$		.40	V dc
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE2}	15		
Base emitter voltage (saturated)	3066	Test condition A; I_C = 7 mA dc; I_B = 0.7 mA dc	$V_{BE(SAT)3}$		.90	V dc
Subgroup 4						
Common emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 10 V dc; I_C = 10 mA dc; f = 100 MHz	$\|h_{fe}\|$	3.0	9.0	
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; f = 1 MHz	C_{obo}		6.0	pF
Input capacitance (output open-circuited)	3240	V_{EB} = 0.5 V dc; I_C = 0; f = 1 MHz	C_{ibo}		9.0	pF
Real part of small-signal short-circuit input impedance	3266	V_{CE} = 10 V dc; I_C = 10 mA dc; f = 300 MHz (see 4.5.2)	RE_{hie}		50	Ω
Charge storage time		$I_C = I_{B1} = -I_{B21}$ = 10 mA dc (see figure 4)	t_s		25	ns
Turn-on time		I_C = 10 mA dc; I_{B1} = 3 mA dc; $V_{BE}(0)$ = -2.0 V dc (see figure 3)	t_{on}		40	ns
Turn-off time		I_C = 10 mA dc; I_{B1} = 3 mA dc; I_{B2} = -1 mA dc; (see figure 3)	t_{off}		75	ns
Subgroups 5, 6, and 7						
Not applicable						

1/ For sampling plan, see MIL-S-19500.

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TABLE II. Groups A, B, and C electrical measurements. 1/ 2/

Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Collector to base cutoff current	3036	Bias condition D; V_{CB} = 20 V dc	I_{CBO1}		25	nA dc
2.	Collector to base cutoff current	3036	Bias condition D; V_{CB} = 20 V dc;	I_{CBO2}		50	nA dc
3.	Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE2}	40	120	
4.	Saturation voltage (collector to emitter)	3071	I_C = 10 mA dc; I_B = 1 mA dc	$V_{CE(SAT)1}$		0.4	V dc
5.	Forward-current transfer ratio	3076	V_{CE} = 1.0 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	Δh_{FE}	±25 percent change from initial value		

1/ The electrical measurements for table IVb (JANTX) of MIL-S-19500 are as follows:

a. Subgroup 2, steps 1, 3, and 4.

b. Subgroup 3, steps 2 and 5.

c. Subgroup 6, steps 2 and 5.

2/ The electrical measurements for table V of MIL-S-19500 are as follows:

a. Subgroup 2, steps 1, 3, and 4.

b. Subgroup 3, steps 1 and 3.

c. Subgroup 6, steps 2 and 5.

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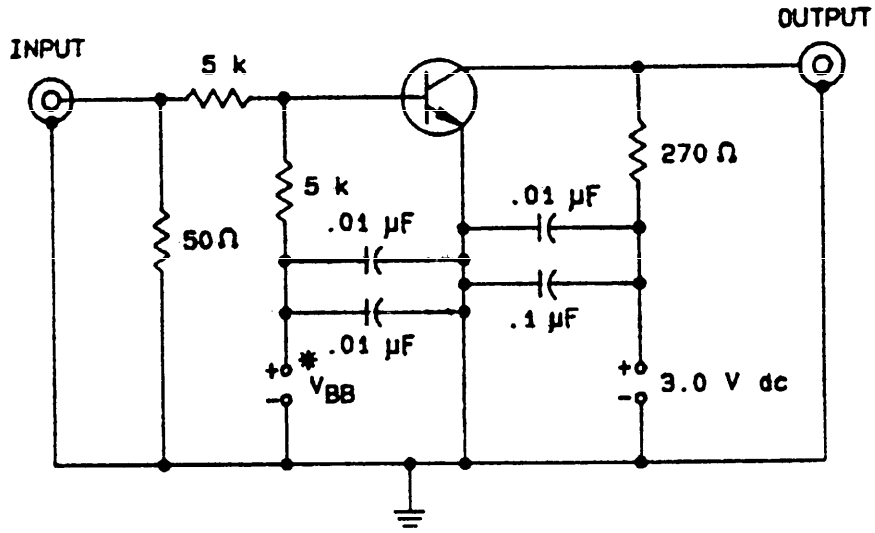
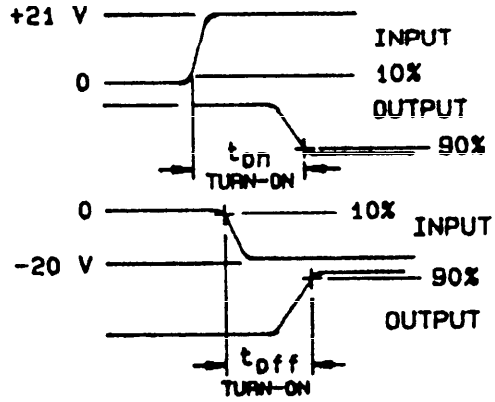


* V_{BB}=-4.0 V dc FOR t_{ON}, +17.0 V dc FOR t_{off}



VOLTAGE WAVEFORMS

NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: Z_{out} = 50Ω, $t_r \leq 1$ ns, PW ≥ 300 ns, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on a sampling oscilloscope with the following characteristics: $Z_{in} \geq 100$ kΩ, $t_r \leq 1$ ns.

FIGURE 3. Turn-on and turn-off time test circuit.

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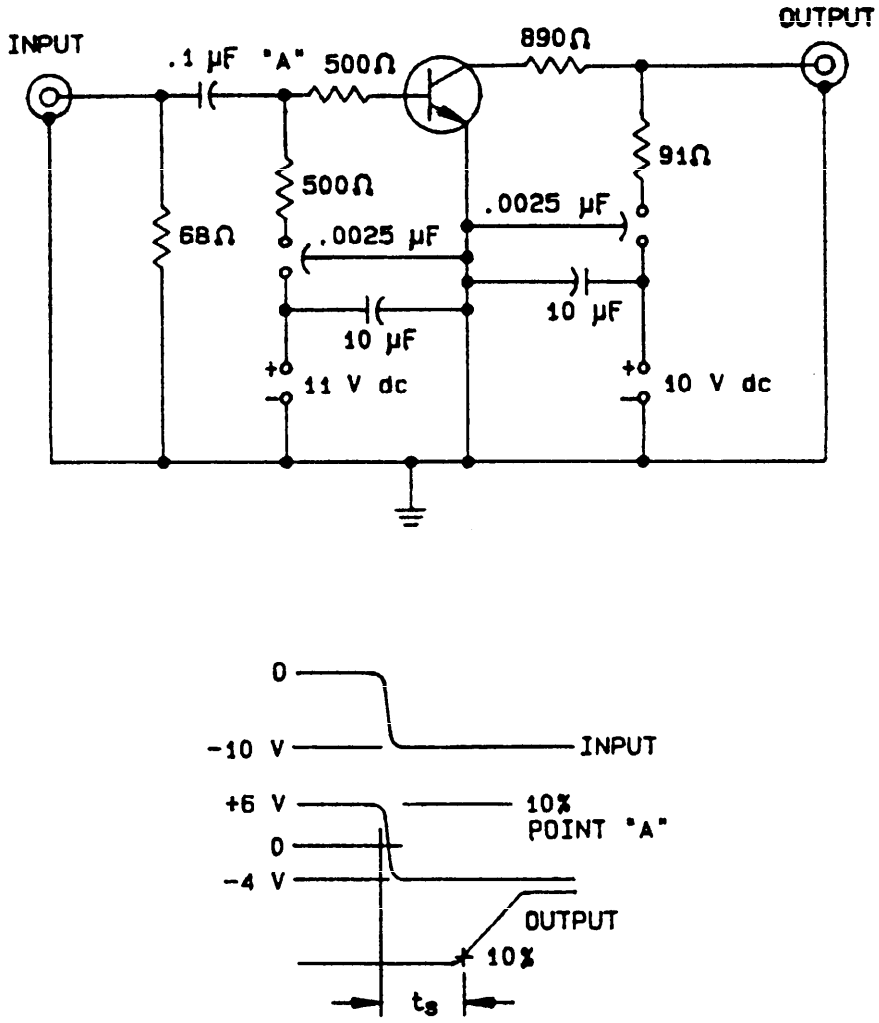

NOTES:
1. The input waveform is supplied by a pulse generator with the following characteristics: Z_{out} = 50Ω, $t_r \leq 1$ ns, PW ≥ 300 ns, duty cycle ≤ 2 percent.
2. Output waveforms are monitored on a sampling oscilloscope with the following characteristics: $Z_{in} \geq 100$ kΩ, $t_r \leq 1$ ns.

FIGURE 4. Charge storage time.

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4.5.2 Real part of small-signal short-circuit input impedance. Test shall be conducted in accordance with method 3266 of MIL-STD-750 except that capacitor "C" as shown in the test circuit shall be removed and connected directly across the collector-emitter output.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-S-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Issue of DODISS to be cited in the solicitation.

b. Solder dip lead finish if required (see 3.3.1).

c. Type designation and quality product assurance level.

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue because of the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:
Army - ER
Navy - EC
Air Force - 17

Review activities:
Army - AR, MI
Air Force - 19, 80, 85
DLA - ES

User activities:
Army - AV, SM
Navy - AS, CG, MC, OS, SH
Air Force - 13, 15

Preparing activity:
Air Force - 17

Agent:
DLA - ES

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INSTRUCTIONS

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-S-19500/312C	920801

3. DOCUMENT TITLE
Semiconductor device, Transistor, NPN, Silicon, Switching, Type 2N708, JANTX

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER		
a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code)	
Mr. Alan Barone	(1) Commercial	(2) AUTOVON
	(513)296-6048	986-6064
ADDRESS (Include Zip Code) Defense Electronic Supply Center Attn: DESC-ECT 1507 Wilmington Pike Dayton, Ohio 45444-5280	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	

DD Form 1426, OCT 89 *Previous editions are obsolete.* 198/290

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